Integrating Cover Crops With & Without Allelopathic Properties in Forage Production Systems of the Upper Midwest

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Cover crops are widely recognized for their potential to contribute to environmental sustainability through factors such as improving soil health and suppressing weeds. In the Upper Midwest, cereal rye (*Secale cereale* L.) is one of the most commonly used cover crops due to its adaptability to various environments. However, its capacity to produce allelopathic compounds remains understudied in agricultural systems. This trait can be beneficial in controlling weeds; however, there is a rising concern among producers about its potential negative effects on the establishment of small-seeded forage crops such as alfalfa (*Medicago sativa* L.). We established a two-year field trial in Arlington, Wisconsin, using a randomized complete block design with four replicates. Treatments were a combination of three cover crops [winter triticale (*Triticum* × *Secale*; non-allelopathic), 'Elbon' rye (mildly allelopathic), and 'ND Gardner' rye (highly allelopathic)] and three cover crop termination-alfalfa establishment methods (termination with herbicide, alfalfa established after tilling; termination with herbicide after biomass harvest, alfalfa established under no-till; and termination with herbicide 2 weeks after alfalfa planted under no-till), using a systems-level approach. Two no-cover crop treatments were also used, one with tilling prior to alfalfa establishment and one with no-till. First-year results indicate that alfalfa forage harvested (sum of two cuts) was significantly reduced following 'ND Gardner' cereal rye compared to winter triticale and 'Elbon' cereal rye, independent of cover crop termination strategy (p-value<0.01; 1,428 vs ~1,784 kg DM/ha, respectively). This resulted in a 23% lower forage harvested when alfalfa was established after 'ND Gardner' compared to no cover crop, while alfalfa established after triticale had no reduction in forage harvested. Although allelopathic cereal rye is expected to suppress weeds, plots previously planted with 'ND Gardner' cereal rye had greater weed biomass (sum of 2 cuts) compared with the triticale treatment (p-value=0.02; 500 vs 305 kg DM/ha, respectively). End-of-season weed density was two-fold greater under 'ND Gardner' relative to other cover crop treatments. This outcome likely occurred because allelopathic effects from 'ND Gardner' penalized alfalfa establishment, allowing more weeds to emerge as the season progressed. Harvesting the cover crop followed by herbicide termination and no-till alfalfa establishment generally benefited alfalfa production and reduced weed biomass. Our results show that alfalfa is negatively affected by highly allelopathic cover crops, but when established after non-allelopathic cover crops, alfalfa shows no forage harvested penalization compared to establishment on fallow land. Removing cover crop biomass prior to alfalfa establishment was the best management strategy for alfalfa biomass production. Additional field data are needed to assess year-to-year variation in these responses, as well as the long-term effects of treatments on alfalfa production and persistence.